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APPLICATION FOR LETTERS PATENT

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**Integrated Circuit Package Separators, And
Methods Of Forming Integrated Circuit Packages**

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0.003 inches wider than pins 60 to insure tight alignment of boards 11, 13 and 15 with subplate 48. After boards 11, 13 and 15 are retained on table 44 by pins 60, cutting mechanism 42 is utilized to cut along the regions illustrated by dashed lines 16, 20, 22 and 24. Such cutting separates discrete integrated circuit packages 14 from one another, as well as from waste regions 21, 23 and 25. The separated circuit packages are retained on table 44 by pins 60 extending through the packages. Specifically, each of individual packages 14 comprises a pair of orifices 19 and is thereby retained on table 44 by a pair of pins 60.

After the IC packages are separated from one another, stripper plate 50 is manually lifted off of subplate 42 to lift the IC packages 14 from pins 60. Once stripper plate 50 is lifted off from pins 60, the individual IC packages can be separated from stripper plate 50. An exemplary method of removing the IC packages from stripper plate 50 is to tilt plate 50 and allow the packages to slide off plate 50. After the packages 14 are removed, plate 50 can be returned to over 48 and used again for separating IC packages.

Difficulties can occur in utilizing the assembly of Fig. 1 for separating IC packages. For instance, separated IC packages can be broken as stripper plate 50 is lifted from subplate 48. It would be desirable to reduce or eliminate such problems.

1 SUMMARY OF THE INVENTION

2 In one aspect, the invention encompasses a method of forming
3 integrated circuit packages. A base having a plurality of pins extending
4 upwardly therefrom is provided. A support is provided over the base.
5 The support has an upper surface and a plurality of holes extending
6 therethrough. The pins extend through the holes and upwardly beyond
7 the upper surface of the support. An actuator is provided beneath the
8 support. A board having a plurality of integrated circuits bonded thereto
9 is provided. The integrated circuits form a repeating pattern of
10 integrated circuit packages across the board, and the board has a
11 plurality of holes extending through it. The board is placed over the
12 support upper surface with the pins extending into the holes in the
13 board. While the board is over the support upper surface, it is cut to
14 separate the integrated circuit packages from one another. After the
15 cutting, the support is vertically displaced by the actuator to lift the
16 support off the pins.

17 In another aspect, the invention encompasses an integrated circuit
18 package separator for separating integrated circuit packages from a board.
19 The board comprises a plurality of integrated circuits bonded thereto,
20 and has a plurality of holes extending within it. The separator includes
21 a base having a plurality of pins extending upwardly therefrom and a
22 support over the base. The support has an upper surface, a plurality
23 of holes extending therethrough, and a pair of opposing ends. The pins

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1 extend through the holes in the support and upwardly beyond the upper
2 surface of the support. The support and pins are configured such that
3 the pins extend into the holes in the board when the board is placed
4 over the support upper planar surface. The separator further includes
5 a pair of actuators beneath the support and configured to vertically
6 displace the support and lift the support off the pins. Additionally, the
7 separator includes a cutting mechanism configured to cut the board while
8 the board is over the support upper planar surface and thereby separate
9 the integrated circuit packages from one another.
10

11 BRIEF DESCRIPTION OF THE DRAWINGS

12 Preferred embodiments of the invention are described below with
13 reference to the following accompanying drawings.

14 Fig. 1 is a diagrammatic, perspective, exploded view of a prior art
15 IC package separator and circuit board assembly.

16 Fig. 2 is a diagrammatic top view of an IC package separator of
17 the present invention.

18 Fig. 3 is a diagrammatic, perspective, exploded view of an IC
19 package separator of the present invention with a stripper plate of the
20 present invention and a circuit board.

21 Fig. 4 is a view of the Fig. 3 assembly with the circuit board
22 retained on the IC separator.
23

Subplate 48a differs from subplate 48 of Fig. 1 in that subplate 48a comprises notches 102 at its ends. Notches 102 are provided to allow room for a pair of forcer plates 104 and 106 to move vertically (in and out of the page of Fig. 2) relative to table 48a. Forcer plates 104 and 106 comprise upwardly extending pins 108 and 110, respectively. Base plate 48a comprises an upper planar surface 115, and forcer plates 104 and 106 comprise upper planar surfaces 117 and 119, respectively. Upper planar surfaces 115, 117 and 119 ultimately support a circuit board assembly (not shown in Fig. 2). Planar surfaces 115, 117 and 119 are preferably substantially coplanar with one another to avoid distorting (e.g., bending) a supported circuit board assembly.

Forcer plates 104 and 106 are connected to actuators 112 and 114, respectively, configured to vertically displaceforcer plates 104 and 106. In the exemplary shown embodiment,forcer plates 104 and 106 are connected to the actuators with screws 116. It is to be understood, however, that other mechanisms could be utilized for joiningforcer plates 104 and 106 to actuators 112 and 114, including, for example, welding.

Actuators 112 and 114 are pneumatic (preferably air-powered) and connected to a gas source 120. An advantage of utilizing air powered actuators is that most wafer fabrication plants have a source of clean dry air available. Accordingly, it is relatively convenient to couple air

1 powered actuators 112 and 114 into existing fabrication plants by simply
2 connecting them to existing air lines. However, it is to be understood
3 that the actuators can be powered by other sources besides air, including,
4 for example, other fluids, such as liquids, as well as non-pneumatic and
5 non-hydraulic sources, such as, for example, electricity.

6 Separator apparatus 100 comprises a cutting assembly (not shown
7 in Fig. 2) and a controller (not shown in Fig. 2), analogous to the
8 cutting assembly 42 and controller 45 of Fig. 1.

9 Referring to Fig. 3, IC circuit package separator 100 is shown in
10 exploded view with a circuit board assembly 10 identical to the assembly
11 described above with reference to Fig. 1.

12 A stripper plate 50a is provided between subplate 48a and circuit
13 board assembly 10. Stripper plate 50a is similar to the stripper plate 50
14 of Fig. 1 in that plate 50a comprises a plurality of orifices 62 configured
15 for receipt of pins 60. However, stripper plate 50a differs from plate 50
16 of Fig. 1 in that plate 50a also comprises orifices 122 configured for
17 receipt of upwardly extending pins 108 and 110 of forcer plates 104
18 and 106. Pins 108 and 110 are preferably tapered pins, such as can be
19 obtained from McMaster-Carr. Exemplary pins have a dimension
20 of 0.248 inches at base, 0.2324 inches at top, and a length of
21 0.75 inches. The taper of the pins can assist in aligning support 50a
22 over the pins during placement of support 50a onto base 48a.
23

1 Stripper plate 50a further differs from plate 50 of Fig. 1 in that
2 plate 50a is configured for receipt of a series of panels 132, 134
3 and 136. Stripper plate 50a can comprise, for example, static-reduced
4 plastic having a thickness of greater than 3/16 inches, and panels 132,
5 134 and 136 can comprise, for example, aluminum. In the shown
6 embodiment, panels 132, 134 and 136 are held to stripper plate 50a by
7 a plurality of screws 138 (only some of which are labeled). It will be
8 recognized, however, that other mechanisms can be utilized for holding
9 panels 132, 134 and 136 to stripper plate 50a, including riveting.
10 Alternatively, panels 132, 134 and 136 can be molded as part of stripper
11 plate 50a.

12 Panels 132, 134 and 136 comprise ribs 140, 142 and 144,
13 respectively (only some of which are labeled). Ribs 140, 142 and 144
14 can assist in supporting board assembly 10. Specifically, IC chips 12 are
15 frequently provided on both an upper surface of circuit board
16 assembly 10, and a bottom surface (not shown). Ribs 140, 142 and 144
17 (also referred to as blocks) have upper surfaces 141, 143 and 145,
18 respectively, which contact the bottom surfaces of circuit boards 11, 13
19 and 15 at locations between the IC chips 12 on the bottom of the
20 board. Preferably, such upper surfaces are provided at a height
21 approximately equal to a thickness of integrated circuit chip
22 components 12. Accordingly, when boards 11, 13 and 15 are rested on
23 panels 132, 134 and 136, respectively, the boards rest on the upper

1 surfaces of blocks 140, 142 and 144 while leaving integrated circuit chip
2 components on the underside of boards 11, 13 and 15 extending between
3 block upper surfaces 141, 143 and 145 and panels 132, 134 and 136.
4 An exemplary block height (or thickness) of blocks 140, 142 and 144 for
5 a DRAM having IC chips 12 with a TSOP dimensional package is 0.040
6 inches ± 0.005 inches. As another example, if IC chips 12 have a SOJ
7 dimensional package, the block height is preferably 0.140 inches ± 0.005
8 inches.

9 Blocks 140, 142 and 144 can be formed as one piece with panels
10 132, 134 and 136. Alternatively, blocks 140, 142 and 144 can be formed
11 as discrete pieces from panels 132, 134 and 136 that are subsequently
12 fastened to the panels.

13 In the shown embodiment, blocks 140, 142 and 144 are provided
14 in a one-to-one correspondence with integrated chip packages 14. Also,
15 in the shown exemplary embodiment each of panels 132, 134 and 136 is
16 identical to one another, and in a one-to-one correspondence with
17 individual boards 11, 13 and 15. It is to be understood, however, that
18 the invention encompasses other embodiments (not shown) wherein the
19 blocks are not provided in a one-to-one correspondence with
20 packages 14, wherein the panels are not identical to one another, and
21 wherein the panels are not in a one-to-one correspondence with the
22 individual boards.
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1 Pins 60 extend upwardly beyond upper surfaces 141, 143 and 145
2 of blocks 140, 142 and 144, and are configured to retain circuit board
3 assembly 10 over stripper panel 50a. In the shown embodiment, pins 60
4 do not extend through panels 132, 134 and 136. However, it is to be
5 understood that the invention encompasses other embodiments wherein
6 pins 60 do extend through such panels.

7 Fig. 3 shows a side perspective view of actuator 112. In such
8 view it can be seen that several ports 150, 152, 153, 154, 155 and 156
9 are provided between actuator 112 and gas source 120. Valves (not
10 shown) are provided between source 120 and one or more of ports 150,
11 152, 153, 154, 155 and 156. Such valves enable fluid to be selectively
12 flowed from source 120 into one or more of ports 150, 152, 153, 154,
13 155 and 156 to selectively control raising and lowering of forcer
14 plate 104 with actuator 112. For instance, flow of gas into port 152 can
15 force a pneumatic cylinder to lift forcer plate 104, and flow of gas into
16 port 150 can force the pneumatic cylinder to lower forcer plate 104.

17 Ports 154 and 156 are connected to release valves 163 and 165,
18 respectively, which enable a pressure on at least one side of the
19 pneumatic cylinder of actuator 112 to be maintained at ambient pressure
20 (generally, about 1 atmosphere). Specifically, release valves 163 and 165
21 comprise outlet ports 157 and 159, respectively, which vent to a
22 surrounding environment. Persons of ordinary skill in the art will
23 recognize that one or more of ports 150, 157 and 159 are utilized as gas

1 outlet ports during lifting of forcer plate 104, and port 152 comprises
2 a gas inlet port during such lifting. In preferred embodiments of the
3 present invention, the release valves are associated with an outlet side
4 of actuator 112 to enable equilibration of a pressure at such outlet side
5 to ambient prior to (and/or during) lifting of forcer plate 104.
6 Specifically, the release valves enable gas to be drained from outlet lines
7 (more specifically, the gas is drained through ports 157 and 159 which
8 are open to ambient conditions) prior to, and/or during, lifting with the
9 actuator. Actuator 114 (Fig. 2) is preferably identical to actuator 112
10 and connected to an identical valve and port assembly as that shown
11 connected to actuator 112. Accordingly, actuator 114 is also connected
12 with release valves configured to equilibrate a back-pressure of the
13 actuator to ambient prior to, and/or during, lifting of stripper panel 50a.
14 The equilibration of pressure at the outlet ends of both of actuators 112
15 and 114 to ambient during a lifting operation can enable both actuators
16 to have an identical back-pressure during the lifting operation. This can
17 facilitate having both actuators lift simultaneously and in unison. Such
18 simultaneous lifting can avoid distortion (such as, for example, bending)
19 of circuit board assembly 10 during the lifting.

20 Stripper plate 50a has an upper planar surface 160 and a pair of
21 opposing ends 162 and 164. Opposing ends 162 and 164 overlie forcer
22 plates 104 and 106, respectively. In operation, actuators 112 and 114
23 are utilized to lift opposing ends 162 and 164 simultaneously and in

unison. Such can be accomplished by, for example, maintaining approximately equal gas pressure at both of actuators 112 and 114 during lifting, and is found to reduce breakage of integrated circuit packages relative to prior art methods. The term "approximately" in the previous sentence is utilized to indicate the gas pressure at both actuators is equal within operational parameters.

A method of operation of separator 100 is described with reference to Figs. 4-6. In referring to Figs. 4-6, subplate 48a is referred to as a base, and stripper plate 50a is referred to as a support. Referring first to Fig. 4, circuit board assembly 10 is shown retained on support 50a. Specifically, circuit board assembly 10 is placed over support upper surface 160 with pins 60 extending through orifices 19 of the circuit boards 11, 13 and 15. Pins 60 and board assembly 10 are aligned such that each of the integrated circuit packages 14 is retained to the support 50a by at least one pin, and, in the shown embodiment, is retained by 2 pins. In the Fig. 4 processing step, actuators 112 and 114 (Fig. 2) are in a lowered position.

Referring to Fig. 5, the individual integrated circuit packages 14 are separated from one another by cutting through boards 11, 13 and 15.

Referring to Fig. 6, actuators 112 and 114 (Fig. 2) are utilized to vertically displace support 50a from base 48a. Preferably, such vertical displacement comprises lifting both of ends 162 and 164 of support 50a substantially simultaneously and substantially in unison with one another.

